REMARKS

The Examiner is thanked for carefully reviewing the present application. The present amendment is in response to the first Office Action mailed on Aug. 1, 2002 regarding claims 1-18. The applicants have thoroughly reviewed the outstanding Office Action including the Examiner's remarks and the references cited therein. The above amendment and following remarks are believed to be fully responsive to the Office Action and render all claims at issue patentably distinguishable over cited references.

Reconsideration and allowance of the present application based on the following remarks are respectfully requested.

Claims 8 and 16 are canceled, and claims 1, 6, 7, 9, 14, 15, 17 and 18 are amended. Claims 1-7, 9-15, and 17-18 are pending. All the changes amended in the specification and claims are made to overcome the rejections of the Examiner. No new matter has been introduced.

Claim Rejections under 35 U.S.C. §112, first paragraph

Claims 8 and 16 are rejected under 35 U.S.C.112, first paragraph, as containing subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with

which it is most nearly connected, to make and/or use the invention. Applicants have canceled claims 8 and 16, and put the limitations of claims 8 and 16 into claim 1 and claim 9, respectively, and amended the specification to further describe the subject matter of original claims 8 and 16, now amended claims 1 and 9. As will be fully explained below, it is respectfully submitted that the description of the subject matter of amended claims 1 and 9 in the amended specification enables one skilled in the art to make and/or use the invention, and the applicants respectfully request that the section 112, first paragraph, rejection be withdrawn.

More particularly, the applicants disclose the oxide layer between the first silicon nitride layer and the second silicon nitride layer (claim 1), or on the silicon nitride layer (claim 9), is removed after the first silicon nitride layer and the second silicon nitride layer, or the silicon nitride layer, is/are removed. Referring to FIG. 9 and the amended paragraph bridging pages 7 and 8 in the attached appendix captioned "VERSION WITH MARKINGS TO SHOW CHANGES MADE", since the edge of the shallow trench 206 is exposed, so the oxide layer 208 in the shallow trench 206 is separated from the oxide layer 208 on the silicon nitride layer 204 outside the shallow trench 206. Therefore, the oxide layer 208 outside the shallow trench 206 is sandwiched between the silicon nitride layer 204 and the silicon nitride layer 210. Furthermore, referring to FIG. 13 and the amended paragraph bridging pages 8 and 9 in the attached appendix captioned "VERSION WITH

MARKINGS TO SHOW CHANGES MADE", after the dry etching process, the photoresist 212 is stripped by using the wet strip or the dry strip so that the silicon nitride layer 210 is exposed. Since the oxide layer 208 outside the shallow trench 206 is sandwiched between the silicon nitride layer 204 and the silicon nitride layer 210 and is only contacted with the silicon nitride layer 204 and the silicon nitride layer 210, the hot phosphoric acid can react with the exposed silicon nitride layer 204 and the silicon nitride layer 210, and remove the oxide layer 208 while stripping the silicon nitride layer 204 and the silicon nitride layer 210 in the wet bench.

Accordingly, the applicants have amended the specification to further describe the subject matter of original claims 8 and 16, now amended claims 1 and 9. It is respectfully submitted that the description of the subject matter of amended claims 1 and 9 in the amended specification enable one skilled in the art to make and/or use the invention, and the applicants respectfully request that the section 112, first paragraph, rejection be withdrawn.

Claim Rejections under 35 U.S.C. §112, second paragraph

Claims 6-8 and 14-18 are rejected under 35 U.S.C.112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicants regard as the invention. These rejections are believed overcome. Applicants have accordingly

canceled claims 8 and 16, and amended the specification and claims 6, 7, 14, 15, 17 and 18, and the applicants respectfully request that the section 112, second paragraph, rejection be withdrawn.

With regard to claims 6, 7, 14, 15, 17 and 18, the applicants have replaced "clean bench" with --wet bench-- and replaced "thermal" with --hot-- in claims 6, 7, 14, 15, 17 and 18 and the specification to recite the wet bench and the hot phosphoric acid clearly. It is respectfully submitted that amended claims 6, 7, 14, 15, 17 and 18 particularly point out and distinctly claim the subject matter of the present invention.

As described above, claims 8 and 16 have been canceled and the limitations of the claims 8 and 16 have been put into claim 1 and claim 9, respectively. As discussed, the applicants have amended the specification to fully explain the subject matter of original claims 8 and 16 and now amended claims 1 and 9. It is respectfully submitted that amended claims 1 and 9 are clear and definite.

Accordingly, the applicants respectfully request that the section 112, second paragraph, rejection be withdrawn.

Claim Rejections under 35 U.S.C. §102(e)

Claims 9-12, 14 and 15 are rejected under 35 U.S.C.102(e) as being anticipated by Andrews et al. (US 2001/0036709). These rejections are

respectfully traversed. As will be fully explained below, it is respectfully submitted that Andrews et al. (US 2001/0036709) do not anticipate the claimed features of the present application, and the applicants respectfully request that the section 102(e) rejections be withdrawn.

With regard to claims 9-12, 14 and 15, the Examiner states that Andrews et al. disclose a method of forming a shallow trench isolation structure which includes providing silicon substrate 10, forming oxide layer 30 on substrate 10, subsequently forming first silicon nitride layer 40 over oxide layer 30 (Paragraph [0017]), then forming shallow trench 20 through first silicon nitride layer 40 and substrate 10 by dry etching (Fig. 1), then forming oxide layer 50 over substrate 10 and filling trench 20 by HDPCVD (Paragraph [0018]), subsequently wet etching oxide layer 50 until first silicon nitride 40 is exposed (Paragraph [0021], and Fig. 2), then forming and defining photoresist 60 over trench 20 (Paragraph [0022], and Fig. 3), subsequently etching a portion of oxide layer 30 by an etching process until first silicon nitride layer is exposed (Fig. 4), then removing photoresist 60 (Paragraph [0023]), then removing remaining portions of oxide layer 50 (Fig. 6), and removing first silicon nitride layer 40 through phosphoric acid wet etching (Paragraph [0023] and Fig. 6).

However, in Fig. 3, Fig. 4, and Paragraph [0023], Andrews et al. disclose that the photo resist 60 is used to protect the oxide 50b within the trench region 20 while the remaining oxide 50a partially covered by photo

resist 60 are etched away. After the oxide 50a partially covered by photo resist 60 are all removed, the photo resist 60 is removed, and the non-trench oxide 50a are etched by using hydrofluoric acid containing wet etching.

In contrast, amended claim 9 of the present application provides a method of forming a shallow trench isolation structure, comprising: forming an oxide layer to cover a substrate, wherein the substrate has a silicon nitride layer formed thereon, and a shallow trench is located in the substrate and the silicon nitride layer; performing a wet etching step to etch the oxide layer until the silicon nitride layer is about exposed; forming a photoresist to cover the oxide layer; defining the photoresist to expose a portion of the oxide layer, and etching the portion of the oxide layer until the silicon nitride layer is exposed; and removing the photoresist and the silicon nitride layer, wherein the oxide layer is removed while the silicon nitride layer is removed. The defined photoresist is used as an etching mask for etching the exposed oxide layer until the silicon nitride layer is exposed. Then, the photoresist has been removed first, and after the photoresist has been removed, the silicon nitride layer is etched away from the exposed portion by using hot phosphoric acid. While the silicon nitride layer is being removed, the remaining oxide layer adhered to the silicon nitride layer is also removed.

Therefore, it is apparent that the claimed features in claim 9 differ from those disclosed by Andrews et al. (US 2001/0036709). The method

in claim 9 is not anticipated by Andrews et al. and is patentable. With regard to claims 10-12, 14 and 15, since claim 9 is patentable, dependent claims 10-12, 14 and 15 each of which depends from independent claim 9 are likewise believed to be patentable.

Claim Rejections under 35 U.S.C. §103(a)

Claims 1-7, 13, 17 and 18 are rejected under 35 U.S.C.103(a) as being unpatentable over Andrews et al. (US 2001/0036709) as applied to claims 9-12, 14 and 15 above, and further in view of Walsh et al. (US 6,228,741) and Wolf. These rejections are respectfully traversed. As will be fully explained below, it is respectfully submitted that Andrews et al. (US 2001/0036709) in view of Walsh et al. (US 6,228,741) and Wolf do not render the claimed invention obvious, and the applicants respectfully request that the section 103(a) rejection be withdrawn.

With regard to claims 1 and 17, the applicants disclose a method of forming a shallow trench isolation structure. Referring to FIG. 10-14 and the amended paragraphs in the attached appendix captioned "VERSION WITH MARKINGS TO SHOW CHANGES MADE", the method forms an oxide layer covering the first silicon nitride layer and filling the shallow trench, and then performs a wet etching step to etch the oxide layer until the first silicon nitride layer is about exposed, so the oxide layer within the shallow trench is separated from the oxide layer above the first silicon nitride layer. Subsequently, a second silicon nitride layer is formed to cover the oxide

layer and the first silicon nitride layer, and a defined photoresist is formed to cover a portion of the second silicon nitride layer. Then, a portion of the second silicon nitride layer and a portion of the oxide layer are etched by using the defined photoresist as a mask until the first silicon nitride layer is exposed. After the first silicon nitride layer has been exposed, the defined photoresist is removed first, and then the second silicon nitride layer and the exposed first silicon nitride layer are etched away by using hot phosphoric acid. Since the oxide layer is sandwiched between the second silicon nitride layer and the first silicon nitride layer and is adhered to the second silicon nitride layer and the first silicon nitride layer, the oxide layer is also removed while the second silicon nitride layer and the first silicon nitride layer are being stripped.

However, in col. 3, lines 15-29 and Fig. 6-9, Walsh et al. (US 6,228,741) disclose that the cap nitride 50 covering the wafer and contacting the mask nitride 20 along the top corner edges of the mask nitride 20 is etched to remove the cap nitride 50 over the active areas and expose a portion of the oxide 40 by using phosphoric acid that is highly selective to oxide, as shown in FIG. 7. After a portion of the cap nitride 50 has been etched away, the exposed oxide 40 is etched to completely remove it over the active areas by using HF that is highly selective to nitride, as shown in FIG. 8. After the oxide 40 outside the trenches 25 has been removed, the mask nitride 20 and the remaining cap nitride 50 are removed, as shown in FIG. 9. The Walsh method has to remove a portion of the cap nitride 50 to expose the oxide 40 outside the trenches 25 first, and remove the

exposed oxide 40 outside the trenches 25 completely, and then remove the mask nitride 20 and the remaining cap nitride 50.

But, the method in the present application removes a portion of the second silicon nitride layer and a portion of the oxide layer to expose the first silicon nitride layer by dry etching, and then the inventive method uses only one etching process to remove the remaining second silicon nitride layer, the remaining oxide layer, and the first silicon nitride layer. The claimed features of the present application are different from those disclosed by Walsh et al. (US 6,228,741).

In addition, the method and etching solution used for removing the first silicon nitride layer, the oxide layer, and the second nitride layer of the present invention are all different from those disclosed by Andrews et al. (US 2001/0036709) and Walsh et al. (US 6,228,741). Since the claimed features of the present application are neither disclosed nor suggested by both Andrews et al. (US 2001/0036709) and Walsh et al. (US 6,228,741), the method and etching solution used for removing the first silicon nitride layer, the oxide layer, and the second nitride layer in the Examiner's combination of Andrews et al. (US 2001/0036709) and Walsh et al. (US 6,228,741) are different from those of the present invention. This represents that the claimed features of the present invention are non-obvious. Besides, since neither Andrews et al. (US 2001/0036709) nor Walsh et al. (US 6,228,741) suggest the idea of removing the remaining silicon nitride layers and the oxide layer sandwiched between the

remaining silicon nitride layers by using only one dry etching step to simplify the processes, there is no suggestion or motivation to combine the technology disclosed by Wolf with the technology disclosed by Andrews et al. (US 2001/0036709) and Walsh et al. (US 6,228,741). The method of the present invention is more simple than the methods disclosed by Andrews et al. (US 2001/0036709) and Walsh et al. (US 6,228,741). Furthermore, the method of the present invention has a large process window for forming the oxide layer covering the shallow trench, since the inventive method does not need to carefully control the deposition of the oxide layer as the methods disclosed by Walsh et al. (US 6,228,741) and Andrews et al. (US 2001/0036709). Therefore, the method of the present invention has made an improvement over the prior art.

As described above, since the features of claim 9 in the present application are not anticipated by Andrews et al. (US 2001/0036709), and the Examiner's combination of Andrews et al. (US 2001/0036709), Walsh et al. (US 6,228,741) and Wolf does not render claim 9 in the present application obvious, claim 9 is patentable. Since claim 9 is patentable, dependent claim 13 that depends from independent claim 9 is likewise believed to be patentable.

Since claims 1, 9 and 17 are patentable, dependent claims 2-7 each of which depends from independent claim 1, dependent claim 13 that depends from independent claim 9, and dependent claim 18 that depends from independent claim 17 are likewise believed to be patentable.

Accordingly, the applicants respectfully request that the section 103(a) rejections be withdrawn.

CONCLUSION

Attached hereto is a marked-up version of the changes made to the claims by the current amendment. The attached appendix is captioned "VERSION WITH MARKINGS TO SHOW CHANGES MADE".

In light of the above amendments and remarks, it is respectfully submitted that the present application is in a condition for allowance and a Notice to that effect is earnestly solicited.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 07-1337 and please credit any excess fees to such deposit account.

Respectfully submitted,

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APPENDIX

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION:

The paragraph beginning on line 18, page 2, has been amended as follow:

Referring to FIG. 4, the oxide layer 108 is polished subsequently by the chemical mechanical polishing and the polishing is stopped until the underlying silicon nitride layer 104 is about exposed. Thereafter, the silicon nitride layer 104 is stripped by the [clean] wet bench and by the high selectivity of the hot phosphoric acid (H_3PO_4) used in the [clean] wet bench. Then, the thermal oxide layer 102 is removed by the wet etching while using the hydrofluoric acid (HF) as the etching solution, so that the shallow trench isolation structure 110 as shown in FIG. 5 is formed.

The paragraph beginning on line 20, page 7, and carrying over onto page 8, has been amended as follow:

Referring to FIG. 9, the oxide layer 208 is etched by the wet etching until the silicon nitride layer 204 above the edge of the shallow trench 206 is about exposed, and the selectivity between the silicon nitride and oxide of the wet etching is high so that the end point of the etching can be controlled. Because the edge of the shallow trench 206 is exposed, so the oxide layer 208 in the shallow trench 206 is separated from the oxide layer 208 on the silicon nitride layer 204 outside the shallow trench 206. In a preferred

embodiment of the present invention, after the wet etching process is completed, the silicon nitride layer 210 is deposited, for example, by the chemical vapor deposition to cover the entire surface of the oxide layer 208, the shallow trench 206, and the exposed silicon nitride layer 204 above the edge of the shallow trench 206, and the structure as shown in FIG. 10 is formed. The oxide layer 208 outside the shallow trench 206 is sandwiched in between the silicon nitride layer 204 and the silicon nitride layer 210. However, it is worthy noted that the silicon nitride layer 210 is not necessary to be formed while the wet etching process is completed in the present invention. The purpose of forming the silicon nitride layer 210 is just to better control the thickness of the shallow trench isolation structure 214.

The paragraph beginning on line 19, page 8, and carrying over onto page 9, has been amended as follow:

Referring to FIG. 13, after the dry etching process, the photoresist 212 is stripped by using the wet strip or the dry strip so that the silicon nitride layer 210 is exposed. Subsequently, the silicon nitride layer 204 and the silicon nitride layer 210 [is] are stripped by hot phosphoric acid in a wet bench, and the temperature of the hot phosphoric acid is between about 150°C and 200°C. [In addition,] Since the oxide layer 208 outside the shallow trench 206 is sandwiched in between the silicon nitride layer 204 and the silicon nitride layer 210 and is only contacted with the silicon nitride layer 204 and the silicon nitride layer 210, so the oxide layer 208 is also stripped while the silicon nitride layer 204 and the silicon nitride layer 210 are stripped in the wet bench. And the thermal oxide layer 202 is